He had found the same kind of ruins all over the country, very frequently on the summit of difficult kopjes. Those at Tati and Impakwe are good examples; but the most perfect, perhaps, of all lies north-west of Tati. The tower there is about sixty feet in length and breadth, and eighty feet high; the walls about fifteen feet thick; and it is entered by a passage winding spirally to the top, which is so arranged as to be commanded by archers from the interior all the way, and is so narrow that it admits of the passage of one person only at a time.

DEVELOPMENT OF MODERN MARINE ENGINEERING.[1]

THE development of modern marine engineering in the United States may fairly be said to have begun with the construction of the engines of the steamship "George W. Clyde," by William Cramp & Sons, in 1871, which were the pioneer two crank compound engines in America. Prior to this our engineers and machinists had brought the simple engine to its zenith of possible development, but with the advent of the compound engine that era ceased to be of interest except in the historical sense.

The discovery of the principle of expansion, and the theory of the compound engine based upon it, long antedate their practical application. The earliest works on steam engineering contain evidences of knowledge of the principle, and foreshadow the application of expansion; but the compound engine as a practical fact is only about twenty-four years old in England, and about twenty years old in the United States. Its success as a fuel economizer at once dominated the construction of simple engines, and all other American ship-builders were compelled to follow Cramp's lead.

From the "George W. Clyde," in 1871, to Mr. Jay Gould's celebrated steam-yacht "Atalanta," in 1882, a period of eleven years, the development of the compound engine was steadily pushed to its climax of air-tight fire-room, forced draught, and the highest boiler-pressure consistent with economy in double expansion. This limit was reached in the "Atalanta;" and during the intervening period Messrs. Cramp & Sons had built about 70,000 registered tons of iron steam shipping, besides a number of yachts and other small crafts.

The era of double expansion terminated in 1885, with the construction of the steam-yacht "Peerless," which was equipped with the first triple expansion engines built in the United States.

This remarkable little ship was built by Cramp & Sons on their own account, at a cost approximating $100,000, simply as a practical experiment in the direction of the advance from two to three expansions of working steam. The result of the experiment left no room for argument as to the efficacy of the new system; and, though a few merchant ships were afterwards built by them with ordinary compound engines, they were merely duplicates of earlier vessels, and none but triple expansion engines were ever afterward designed or recommended by that firm.

In the "Peerless," as an experimental ship, Messrs. Cramp & Sons went to what has since been recognized as the upper limit of economical boiler-pressure for the purposes of triple expansion, which was 155 pounds. The registered tonnage of the "Peerless" was 228 only, but her engines developed about 1,060 indicated horse-power, giving her a speed of 17¼ knots, which made her the fastest steam-yacht of her time and class.

From the "Peerless" in 1885 to the "Vesuvius" in 1889 was a period marked by tremendous progress. In the latter vessel a power of 4,440 horses was developed in 252 tons weight of machinery, and applied to the propulsion of about 905 tons of displacement, the result being a speed of 21.65 knots an hour.

During this period Messrs. Cramp & Sons also built the horizontal triple expansion engines of the "Newark," "Philadelphia," "Baltimore," and "Yorktown," United States men-of-war, together with about 56,000 horse-power of triple expansion machinery for merchant vessels, a compound oscillating engine for the Stonington Steamship Line steamer "Connecticut" (with cylinders 56 inches and 104 inches respectively, and 11 feet stroke), — the largest engine of that type ever built, and carrying 110 pounds of steam-pressure,— together with several heavy compound pumping-engines for water-works, ranging in capacity from 10,000,000 to 20,000,000 gallons per day.

Advantage was taken of this school of development by the Navy Department, and Chief Engineer George W. Melville was stationed at the ship-yard of Cramp & Sons as inspector of machinery. While serving as such, Mr. Melville designed the engines of the cruiser "San Francisco," and laid broad and deep the foundation of that knowledge of marine engineering which, since his promotion to the chiefship of the Bureau of Steam Engineering, has found expression in a group of machinery designs aggregating over 150,000 horse-power, all of which are now in various stages of construction, and classed by all competent critics at home and abroad as representing advanced types of marine engineering in every sense.

The latest of Messrs. Cramp & Sons' engines brought to trial are those of the United States cruiser "Newark," which are of the horizontal, direct-acting, three-cylinder type. They weigh, including water in the boilers, 761 tons, and developed, on four hours' trial, 8,660 indicated horse-power, or 11.64 horse-power to the ton of weight, which exceeds any other performance of that type of machinery.

At the present time this concern has in the course of construction the machinery for two 10,000-ton battle-ships, one armored cruiser of 3,100 tons, and one protected cruiser of 7,300 tons, embracing, in all, eleven engines of approximately 60,000 indicated horse-power, of which three are to be placed in the latter vessel to drive triple screws, and designed to produce a speed of 21 knots.

It is quite generally conceded that, in the production of these colossal machines, the limit of size and weight of boilers of the cylindrical or tubular type has been reached; those for the armored cruiser "New York" having a diameter of 15.9 feet, requiring a shell plate thickness of 1.32 inches, and weighing 70 tons each when ready for installation on board ship.

The machinery plans for the 8,200-ton armored cruiser, and the 7,300-ton protected cruiser, present several interesting novelties. The first named is to be powered with four engines, two working on each shaft, and provided with means of disconnection so as to cruise under half power under ordinary circumstances. These four engines are installed in separate water-tight compartments. The power is 4,500 each, or 18,000 collectively, and is expected to produce a speed of twenty knots.

In the 7,300-ton protected cruiser there are to be three engines, on three shafts. Two of the engines, driving the port and starboard shafts, are placed in the usual manner on twin screw vessels. The third, driving the central shaft, is placed abaft the other two, each having its own compartment.

These are to be among the most powerful machines ever built, having 7,000 indicated horse-power each, or 21,000 collectively, and are to produce a speed of twenty-one knots.

[1] From The Crank.

SUBMARINE GUNS.

C. S. BUSHNELL of New Haven, vice-president of the Ericsson Coast Defence Company, which has just had the old "Destroyer" taken out of the Brooklyn Navy Yard and hauled up on Simpson's dry dock at South Brooklyn for repairs, says, in the *New York Times*, in regard to the fitting-up of the vessel for the trial of a newly invented gun, —

"On the 'Destroyer' the late Capt. Ericsson and C. H. Delamater spent $150,000. The vessel is 120 feet long, and is substantially constructed, though now in great need of repairs. Our company has a capital of $250,000. We are fitting up the vessel for the purpose of testing a gun that will fire under water. Now, with the heavy nettings which the big war-vessels have for the protection of themselves against torpedoes, the ordinary projectiles are almost useless.

"But with the gun that is to be tested on the 'Destroyer' we can make a projectile penetrate any of the nettings that are now in use. We are to use a sixteen-inch gun. That which we will experiment with is being constructed at Bethlehem, Penn., and is about half done. It is to be 35 feet in length. The projectile is to be 25 feet long, and to throw it a charge of twenty-five